

## **VV&A and the HLA**

The DoD Modeling and Simulation Master Plan established the DoD Common Technical Framework, which includes the High Level Architecture (HLA). The overall objective of the Common Technical Framework is to promote and support the interoperability and reuse of modeling and simulation (M&S) resources within DoD. This annex discusses introductory facets of the Verification, Validation and Accreditation (VV&A) of models and simulations. VV&A is part of the infrastructure which supports the Common Technical Framework and is referenced as Objective 5-2 of the DoD M&S Master Plan. Specific emphasis is placed on the application of a generic VV&A process to the development of HLA federations.

### **1 Basic VV&A**

#### **1.1 VV&A Defined**

The current definitions for VV&A can be found in DoD Directive 5000.59, the DoD M&S Glossy (DoD 5000.59-M), and the recently published DoD Instruction 5000.61, dated 29 April 1996, “DoD Modeling and Simulation (M&S) Verification, Validation and Accreditation (VV&A)”. The definitions originated from a series of simulation validation workshops held by the Military Operations Research Society (MORS) from 1989 to 1994. The definitions are:

Verification - the process of determining that a model implementation accurately represents the developer’s conceptual description and specifications

Validation - the process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model

Accreditation - an official determination that a model is acceptable for a specific purpose

#### **1.2 Current Status of VV&A Practice in DoD**

There is a continuum of current perceptions about VV&A which exists today in DoD. On one end of the continuum, there are those who are successfully doing VV&A. They understand that the credibility of a model is integral to the success with which it is used, and their application of M&S technology is, therefore, made more valuable to both their customers as well as to future users of that model who can leverage off of their VV&A accomplishments.

At the other end of the continuum are those in the DoD community who don’t know about VV&A, don’t care about VV&A, argue that it is too resource intensive, and claim that VV&A does not provide value added. Fortunately, these people are in the minority.

The majority of DoD fall in the center of the continuum. They know that they need to do VV&A, but are unsure as to what to do or how to go about it. Their reactions range from mild concern to virtual panic.

The goal of the DoD VV&A effort is to provide the information and tools necessary to those in the middle so that they successfully and (more or less) painlessly join the ranks on the left. The minority to the right will either join the crowd or get run over by the oncoming train.

### 1.3 The DoD VV&A Effort

The Defense Modeling and Simulation Office (DMSO) is charged by USD(A&T) to carry out the DoD M&S Master Plan. In responding to Objective 5-2, DMSO has identified the customers of the DoD VV&A effort to be all DoD developers and users of M&S. The underlying requirement for VV&A is that all developers and users must concern themselves with the credibility of the models and simulations used by DoD if the decisions made as a result of that use are to be credible and usable to the decision maker.

The DoD VV&A effort recognizes that common misperceptions exist, particularly the concern among many in DoD that VV&A is too costly. There are also misunderstandings which fail to recognize that both verified and validation - that simply ensuring the “V&V” of the federates does not automatically guarantee the overall credibility of the federation when everything is “connected”. Conversely, V&V of a federation does not imply that all of its component models are, by virtue of association, also sufficiently verified and validation for the purpose for which the federation was developed. These issues are particularly relevant to HLA developers and users. Finally, information on VV&A is hard to find and hard to understand, and DMSO is tasked with removing these barriers as well.

### 1.4 The DoD VV&A Recommended Practices Guide

In Fiscal Year 1995, DMSO formed a Technical Support Team to write a Recommended Practices Guide for VV&A. The first publication of the of the Guide is scheduled for 1 October 1996. Six chapters provide information on VV&A including: an overview which discusses the reasons for and benefits of doing VV&A, general principles, processes, technical fundamentals, accreditation, and common reporting formats. A “How to Read this Document” introduction provides guidance to the reader on what may be interest depending upon his organizational level - decision maker, program manager, or technical staff. The focus of the Guide is to provide a generic VV&A process that is applicable to all readers, then provide specific guidance for HLA users and users in transition from other forms of federation, such as DIS and ALSP. Subsequent to its initial publication, the Guide will be expanded to capture specific examples of VV&A in HLA federations as these programs mature. It should be noted that the generic process is equally applicable to standalone models as it is to federations of models.

The VV&A Technical Support Team was selected for the broadest possible representation across DoD uses of M&S in government, academia and industry. The federation for the Guide drew upon the prior work of the team members, as well as a comprehensive review of existing Service directives and practices, which were folded in to the Guide. Every effort was made to minimize conflict with other available guidance, so as to help, rather than confuse, the reader. In addition to review by the VV&A community, the draft Guide was distributed to selected program offices for comment and made available on the Internet via the DMSO home page for general review.

## 1.5 New DoD VV&A Directions

Continuing work includes planned extensions to cover VV&A specific to the three functional areas - acquisition, analysis and training. As noted earlier, the maturation of the HLA, and proven examples of VV&A efforts in connection with the protofederations, will be drawn upon to provide case studies in a subsequent version of the Guide. Finally, DMSO will continue to leverage the efforts of VV&A and ensure that VV&A is consistent with the Common Technical Framework and its supporting infrastructure. The application of the generic VV&A process to the HLA federation development process was a first step in providing such an interface. The extension of the Modeling and Simulation Resource Repositories (MSRR) directories data model to include VV&A information is another example of where such interfacing has begun. Future efforts will include the VV&A of the Modular Reconfigurable C4I Interface (MRCI), the Conceptual Models of the Mission Space (CMMS), and bridging to the Data Verification, Validation and Certification (VV&C) and Environment representation initiatives. A VV&A on-line bibliography to provide ready reference, and the continued education and outreach to the M&S community are also planned.

## 2 Development of the Generic VV&A Process

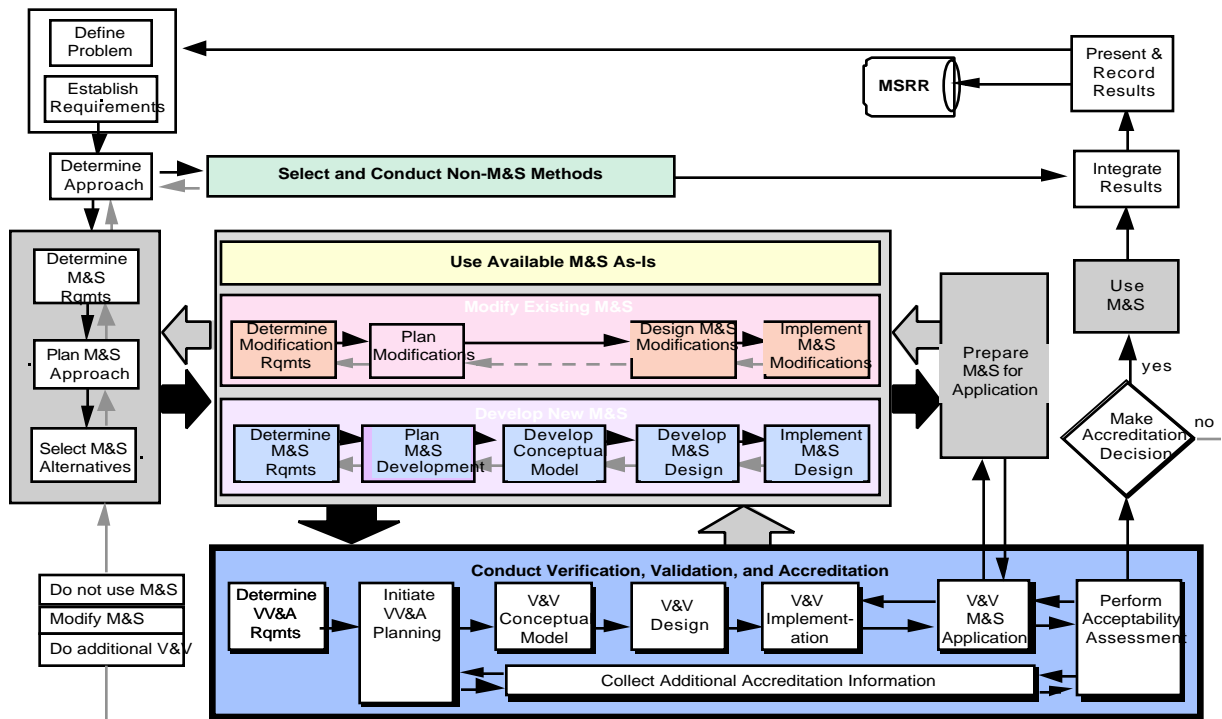
### 2.1 Background

The VV&A Technical Support Team was originally tasked with developing an overlay to the HLA federation development process. A second tasking required that the DoD VV&A Recommended Practices Guide be useful to developers and users of individual simulations - the federates - as well as HLA federation developers. Ultimately, it was recognized that guidance would be required to assist those transitioning existing programs to HLA, with transitioning their VV&A efforts also.

To meet the varying needs of these communities, the VV&A Technical Support Team developed a generic VV&A process which incorporates all tasks that might be associated with the performance of VV&A regardless of the form of M&S application. (Figure 1)

### 2.2 VV&A Within The M&S Lifecycle

The generic VV&A process is placed within the context of the M&S lifecycle. The success of any VV&A effort depends on how the use of M&S is formulated at the beginning of an application. The problem that is to be addressed must be clearly defined, along with the requirements of the task and how the acceptance or accreditation of the models and simulations will be judged.



**Figure 1 VV&A Process in the M&S Life Cycle**

Figure 1 acknowledges that M&S is only one tool which may be employed in solving the problem (green box), although the primary emphasis is on the three means by which M&S might be applied. A user might wish to use an existing, or legacy, model (yellow box), modify a legacy model (pink box), or develop a new model (lavender box). Much of this decision is dependent on whether the underlying assumptions, limitations and constraints of an existing model are acceptable and appropriate to the intended use. The VV&A process is depicted in the blue box.

One important feature of this diagram is that the accreditation decision is neither a “fait accompli” nor a binary choice. If the decision maker chooses not to accredit a model, that

decision may indicate a clear prohibition to use the model, direction to modify the model further, or to perform additional V&V to provide a better assessment of the model's credibility.

Once an accreditation decision has been made and the simulation run, the results are analyzed, integrated with the results of other tools used in the solution of the problem, and presented to the user. The results of a model's VV&A is added to the MSRR to assist future users of that model, thereby encouraging M&S reuse and minimizing VV&A cost over time.

Chapter 3 of the DoD VV&A Recommended Practices Guide provides more detailed information regarding the M&S lifecycle and how VV&A interfaces with the choice and use of M&S.

### 2.3 The Steps of the VV&A Process

This section focuses on the blue box in Figure 1 which illustrates the generic VV&A process. As with the overall decision of how to solve a given problem and the tools that will be used, requirements are a first and necessary step. VV&A requirements are generated from a detailed analysis of the intended application of the model. This analysis reinforces the previously stated importance in the M&S lifecycle of clear problem definition, requirements and criteria by which the model will be tested and accepted. VV&A requirements are also determined through identification of the most critical issues and relevant features of the model which will be used. Model functions and features which do not directly affect problem resolution will have less impact on the scope of the VV&A effort. The DoD VV&A Recommended Practices Guide provides useful tips for effectively tailoring your VV&A effort to ensure that your credibility assessment is adequate to the task without overexpending scarce resources.

Initiating VV&A planning requires that a detailed plan be written which defines what level of effort will be accomplished, how it will be accomplished, by whom, by when, and at what cost. Large scale efforts often include a simulation plan in their documentation, and a VV&A plan is a natural and essential part of the simulation plan. It need not be extensive, but should provide a reasonable level of detail to inform the decision maker and other key team members what the VV&A effort is designed to achieve, how it will be achieved, and its overall contribution to the M&S application.

The next three steps of the generic VV&A process are the heart of any VV&A effort. Any use of M&S includes someone's idea of what that model looks like, what it does, and how it performs. The V&V of the conceptual model simply affirms that the underlying assumptions of that idea are correct and that the requirements are accurately represented for the problem at hand. It ensures that the simulation as envisioned is likely to provide results realistic enough for the intended use.

Design V&V checks the M&S as it is constructed or modified to ensure that the actual design accurately reflects the conceptual model. Where a legacy model is being used "as is", design V&V affirms that the model's current detailed design continues to meet the requirements of the

intended application and that there are no underlying assumptions or limitations which constrain the accurate and realistic use of that model for the application at hand.

Finally, the simulation is constructed or modified, and the implementation of those changes are verified and validated for accuracy and credibility against the detailed design specifications. Once the simulation is complete, it is prepared for actual use and the V&V team checks to ensure that the platforms are configured correctly and that the operators are properly instructed in the use of the simulation. An acceptability assessment is conducted to determine whether the simulation as implemented meets the requirements of the application, and identifies any shortfalls and what their impact may be on the simulation results.

Outside of the VV&A process, the lifecycle process then takes precedence. An accreditation decision is made and if accredited, the simulation is run and its performance and results are compared with the measures of effectiveness that were established as part of the requirements definition process. Results and all documentation pertaining to the VV&A effort are archived for future reference in the MSRR.

### 3 VV&A in the HLA Federation Development Process

The HLA federation development process has been slightly modified to accommodate the VV&A overlay, as illustrated in Figure 2.



Development all involve Conceptual Model V&V. The definition of objects and interactions which result from the Conceptual Analysis stage requires V&V to ensure that those objects and interactions are accurately represented.

Identification of the federates and their individual responsibilities are one focus of Federation Design. Here, V&V plays a major role in checking the V&V history of the federates, and determining what additional V&V is required to make those simulations credible for the purposes of the federation. Emphasis is placed on responsibilities within the federation.

Another objective of Federation Design is to identify potential opportunities for reuse of existing Federation Object Models (FOMs) and Simulation Objects Models (SOMs). FOMs and SOMs provide descriptions of the capabilities of federations and federates to assist other users in determining their suitability for new applications. Both FOMs and SOMs need to be validated against the federations and simulations which they represent to ensure consistency in the descriptions provided with the actual federation or federate.

The Federation Development stage is the final area where V&V of the Conceptual Model occurs. Federation Development bridges the V&V function across the Conceptual Model to V&V of the Federation Design (lavender overlay). Conceptual and design activities include FOM development, as well as identification of common functionalities, data requirements, object relationships, common syntax and semantics. As design features become more detailed, V&V is performed to ensure that they accurately reflect the intent of the conceptual design. MSRR resources are also called upon during Federation Development, including histories of previous VV&A efforts on federates and federations which are similar in application or which may be considered for application or modification in the current federation. Information gained from the MSRR is verified to ensure compatibility and to validate object interactions across federates.

Design V&V extends out from the Federation Development stage to include part of the Federation Required Executive Details (FRED). The FRED describes how the FOM works internally to the federation. Network requirements, physical connections, and delineation of platforms and nodes must all be verified against the developer's specifications. HLA compliance testing provides much of this V&V requirement.

V&V of the implementation of the federation involves the products of the federation development process, portions of FRED, the RTI initialization data, and the federation test (orange overlay). Federation documents generated during development provide excellent tracing for V&V activities. RTI initialization data provides the physical implementation of the rules, interface specifications and object model. This data, as well as that obtained from FRED, serve as valuable conduits through which V&V is performed to ensure that the implementation of the federation accurately reflects the intended design.

Federation Testing includes both HLA compliance testing and federation functional testing. The former ensures that when connected to the RTI, the interface specifications are handled properly

and information is passed correctly. This correlates directly to verification which checks the implementation against the developer's conceptual description and specifications, A similar parallel can be drawn between functional testing, which looks for logical interactions and ensures that the information which is passed makes sense, with validation, which tests the credibility of the implementation against the real world.

Figure 2 also indicates where reports and documentation of the VV&A effort should occur. These documents should be an integral part of the overall application of M&S.

#### 4 Conclusion

This annex is not intended to provide detailed instructions in the performance of VV&A, but to provide a primer in the key aspects of VV&A and how they are applied within an HLA context. The reader is strongly encouraged to become familiar with DoD and Service policy on VV&A, and to use the DoD VV&A Recommended Practices Guide in formulating and implementing a VV&A program for HLA applications.